EVALUATION OF THE OUTCOME OF SHOULDER AND ELBOW FUNCTIONS AFTER MULTIPLE NERVE TRANSFERS IN BRACHIAL PLEXUS AVULSION INJURIES – RETROSPECTIVE STUDY

Dissertation submitted to

THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY

In partial fulfillment of the regulations

for the award of the degree of

M.Ch. Branch - III

PLASTIC AND RECONSTRUCTIVE SURGERY

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INDIA

AUGUST 2013

CERTIFICATE

Certified that this dissertation titled EVALUATION OF THE OUTCOME OF SHOULDER AND ELBOW FUNCTIONS AFTER MULTIPLE NERVE TRANSFERS IN BRACHIAL PLEXUS AVULSION INJURIES – RETROSPECTIVE STUDY is a bonafide work of **Dr.R.VISWAMADESH** Post Graduate in M.Ch.Plastic and Reconstructive Surgery during 2010 – 2013 at the Institute for Research and Rehabilitation of Hand and Department of Plastic Surgery, Govt. Stanley Medical College. This study was done under my supervision and guidance.

DEAN

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DECLARATION

I solemnly declare that this dissertation titled **"EVALUATION OF THE OUTCOME OF SHOULDER AND ELBOW FUNCTIONS AFTER MULTIPLE NERVE TRANSFERS IN BRACHIAL PLEXUS AVULSION INJURIES"** is done by me under the guidance and supervision of **Prof.J.Mohan,M.S.,M.Ch.,** Professor & Head of the Department, IRRH and DPS Stanley Medical College, Chennai. This dissertation is done in IRRH and DPS Stanley Medical College Chennai and submitted to the TamilNadu Dr.MGR Medical University, Chennai in partial fulfillment of the university requirements for the award of the degree of M.Ch., Plasticand Reconstructive Surgery.

Place : Chennai
Date :

DR R.VISWAMADESH
Postgraduate Student,
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I am especially happy to thank my co-residents for their comments, corrections and help in the execution of this maiden effort.

I am extremely thankful to all the patients who readily consented and cooperated in the study.

INSTITUTIONAL ETHICAL COMMITTEE,
STANLEY MEDICAL COLLEGE, CHENNAI-1

Title of the Work: Evaluation of the outcome of shoulder and elbow functions after multiple nerve transfers in brachial avulsion plexus injuries – retrospective study

Principal Investigator : Dr.R.Viswamadesh

Designation : PG in M.Ch(Plastic Surgery)

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The request for an approval from the Institutional Ethical Committee (IEC) was considered on the IEC meeting held on 13.07.2011at the Council Hall, Stanley Medical College, Chennai-1 at 2PM

The members of the Committee, the secretary and the Chairman are pleased to approve the proposed work mentioned above, submitted by the principal investigator.

The Principal investigator and their team are directed to adhere to the guidelines given below:

1. You should inform the IEC in case of changes in study procedure, site investigator investigation or guide or any other changes.
2. You should not deviate form the area of the work for which you applied for ethical clearance.
3. You should inform the IEC immediately, in case of any adverse events or serious adverse reaction.
4. You should abide to the rules and regulation of the institution(s).
5. You should complete the work within the specified period and it any extension of time is required, you should apply for permission again and do the work.
6. You should submit the summary of the work to the ethical committee on completion of the work.

23/3/13

MEMBER SECRETARY,
IEC, SMC CHENNAI

EVALUATION OF THE OUTCOME OF SHOULDER AND ELBOW FUNCTIONS AFTER MULTIPLE NERVE TRANSFERS IN BRACHIAL PLEXUS AVULSION INJURIES

RETROSPECTIVE STUDY

PERIOD OF STUDY- FROM 2007- 2011

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INTRODUCTION

Brachial plexus injuries are most common in young men. The majority of injuries are sustained in motor vehicle accidents (traction or crush); less frequently they may be the sequelae of penetrating wounds, tumors, obstetrical trauma, or radiation. Brachial plexus injuries can occur at several levels and usually involve multiple structures of the thorax and upper extremity. Traumatic brachial plexus injury causing devastating functional deficits of upper extremity and requires complex surgical reconstruction. With the advances in microsurgical techniques and innovations it is possible to restore shoulder stability and elbow function

Reconstructive options to restore basic grasp functions of hand are available with lower plexus rupture or avulsion. Many reconstructive options including multiple intra and extraplexial nerve transfer, free functioning muscle transfers to the paralyzed limb are integral parts of the total reconstructive plan. The complexity and rigor of these procedures for both the reconstructive team and patient are substantial. Successful outcomes require not only consideration of the nature of the plexus injury including location, mechanism, and elapsed time from injury and presence of associated injuries but also surgical expertise, practical operative time constraints, and ability to provide and attend prolonged post-operative rehabilitation.

PATTERN OF APPROACH TO THE STUDY

AIM OF THE STUDY: TO EVALUATE THE OUTCOME OF SHOULDER AND ELBOW FUNCTIONS AFTER MULTIPLE NERVE TRANSFERS IN BRACHIAL PLEXUS AVULSION INJURIES

CONSENT:INFORMED CONSENT

STUDY DESIGN-RETROSPECTIVE STUDY

PERIOD OF STUDY- FROM 2007- 2011

ETHICS COMMITTEE CLEARANCE- CLEARED

INCLUSION CRITERIA:

BRACHIAL PLEXUS ROOT AVULSION INJURIES

EXCLUSION CRITERIA

1. BRACHIAL PLEXUS INJURIES OTHER THAN AVULSION

2. ASSOCIATED MAJOR INJURIES

3. ASSOCIATED WITH SKELETAL INJURIES OF SAME LIMB

4. CHILDREN LESS THAN 12 YRS

5. CONGENITAL BIRTH PALSIES

6. MENTALLY UNSTABLE AND UN CO-OPERATIVE PATIENTS

MATERIALS AND METHODS

IRRH & DEPARTMENT OF PLASTIC SURGERY,

MEDICAL RECORDS DEPARTMENT,

FOLLOW UP EVALUATION OF PATIENTS UNDER GONE NERVE TRANSFER

INVESTIGATIONS

NERVE CONDUCTION STUDY

MRI

FINANCIAL ASSISTANCE : NIL

CONCLUSIONS IS BASED ON RESULTS OF FOLLOW UP

REVIEW OF LITERATURE

ANATOMY

The anterior primary rami of the cervical roots C5,C6,C7,C8 and thoracic T1 spinal nerve, forms the brachial plexus.This plexus gives motor innervations to the muscles of shoulder, anterior and posterior chest, muscles attached to gleno-humeral joint,extrinsic and intrinsic muscles of upper limb and sensory innervations of the same upper limb, except the skin on the medial aspect of arm.

If C4 provides significant contribution, but T1 does not contribute,this is called pre-fixed brachial plexus.If T2 has significant contribution but C5 does not contribute then it is called the post-fixed brachial plexus,

Prefixed and post-fixed brachial plexus are found in about 3% of the cases from Narakas.

The brachial plexus originates at the scalene as roots, forms the trunks traversus under the clavicle, as divisions and cords passes through the axilla as branches. It is composed of 5 roots, 3 trunks, 6 divisions -2 from each trunk, 3 cords. Terminal branches arise from these cords

ROOTS

Each spinal nerve is formed by the a ventral root (motor fibers) and a dorsal root (sensory fibers). The dorsal root ganglia are formed with-in the inter-vertebral foramen,outside the dura mater of the spinal cord close to the foramen. The dorsal roots and ventral roots unite to form the mixed spinal nerve.The C5,C6,C7 roots gives branches which unite to form the long thoracic nerve of bell. The dorsal scapular nerve arises a branch from C5 root

TRUNKS

Between the anterior and middle scalene muscles and posterior to clavicle, the postganglionic spinal nerves initially combine to form the three trunks – upper (C5 and C6), middle (C7) and lower(C8,T1). The superior trunk gives two branches - the suprascapular nerve and a nerve to subclavius.

DIVISIONS

Each trunk is divided into anterior and posterior division just proximal to or directly under the clavicle.

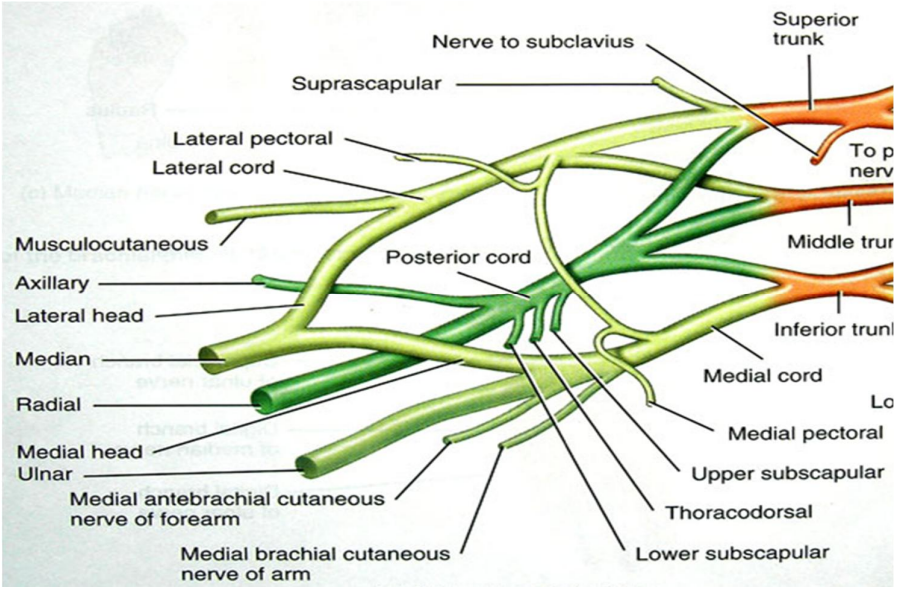
CORDS AND BRANCHES

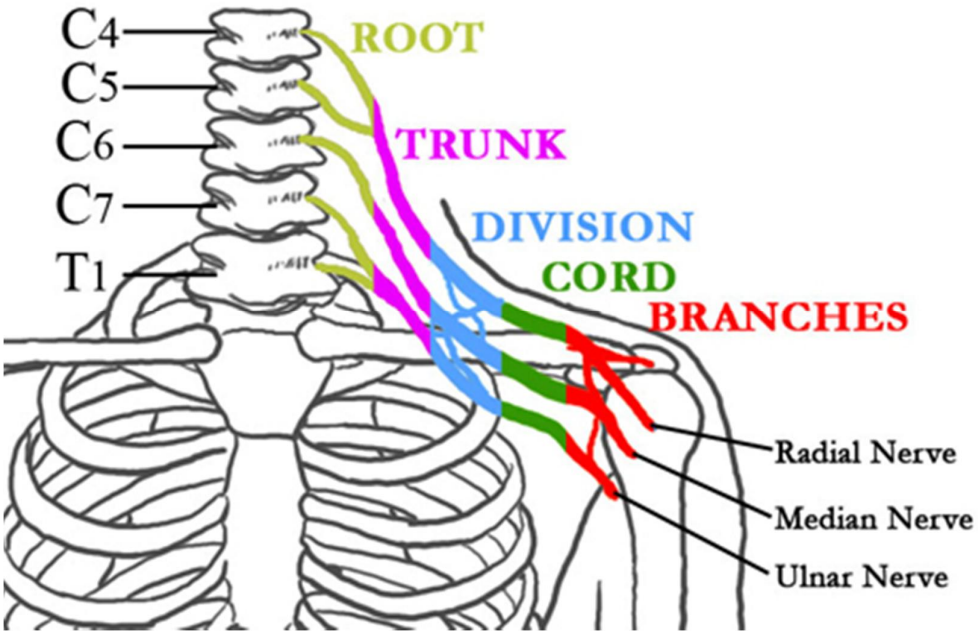
Posterior division of all trunks unites to form the posterior cord. The anterior divisions of superior and middle trunk unites as the lateral cord. The medial cord is formed by the anterior division of inferior trunk. The medial, lateral, and posterior cords are related to their position along the axillary artery.

The branches of posterior cord includes the upper and lower subscapular nerves, the thoracodorsal nerve originates between them and then the cord divides as axillary and radial nerves. The lateral pectoral nerve takes origin from the lateral cord, and the medial pectoral nerve from the medial cord. The musculo-cutaneous nerve is the continuation of lateral cord. The median nerve is formed from a branch from medial and lateral cords. The medial cord gives the medial brachial cutaneous and the medial antebrachial cutaneous nerves and then continues as ulnar nerve

The roots and trunks are formed proximal to the clavicle. The cords and branches are distal to the clavicle. The plexus exits between the anterior and middle scalene. It is situated in close proximity to the axillary artery. The anatomical landmarks in the supraclavicular region namely the external jugular vein, superficial motor cervical plexus, inferior belly of

omohyoid muscle, transverse cervical artery, scalene muscles phrenic nerve are very important to locate the brachial plexus

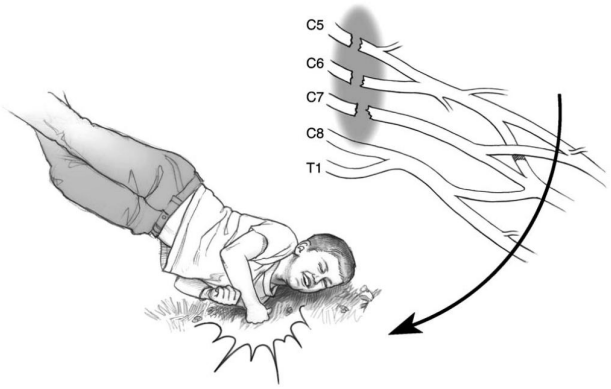




PATHOPHYSIOLOGY

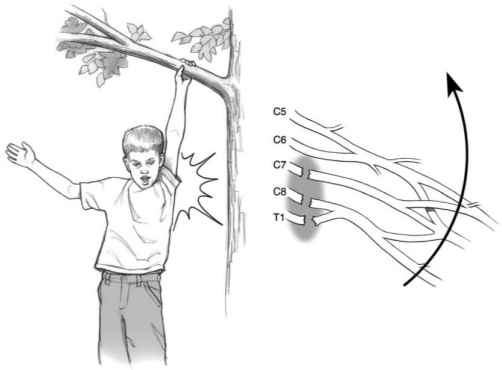
Mechanism of brachial plexus injuries includes

1) Neck–shoulder separation injuries. The head and neck are moved away violently from the ipsilateral shoulder can cause avulsion injuries of upper roots C5,C6,C7. The arm is at the side and the first rib acts as a fulcrum the traction forces are directed preferentially in line with the upper plexus.



2) Arm-shoulder separation injuries. The arm is moved violently and abducted overhead. This causes avulsion of lower roots C8 &T1.The force is directed in line with C7, the arm is raised because the coracoid acts as a fulcrum.

Well-formed transverse radicular ligaments that help resist traction forces at C5, C6, while C7; C8 and T1 lack these ligaments hence more prone for avulsion injuries



Preganglionic or postganglionic injuries occurs out of traction forces. Preganglionic injuries are the lesions proximal to dorsal root ganglion, in the spinal canal, and foramen. Preganglionic root avulsion may be central or direct from the spinal cord or intradural. Preganglionic root avulsions due to the axons in continuity with the cell bodies in the dorsal root ganglion do not cause wallerian degeneration or neuroma formation. Postganglionic lesions occurs distal to the spinal ganglion. The physiological properties are similar to other peripheral nerve injuries.

Brachial plexus injury may be caused by

a) Trauma (open or closed injury)

b) Compression,

c) Tumor

d) Infection, inflammation

e) Toxins and others.

CLASSIFICATION OF BRACHIAL PLEXUS INJURIES

Millesi classified brachial plexus injury into four levels(4);

1.Supraganglionic root (level I)

2.Infraganglionic root (level II)

3.Trunk (Supraclavicular), (level III)

4.Cord (infraclavicular) (level IV)

Alnot classified as preganglionic and postganglionic root lesion to describe the same lesions as Millesi's level I and II.

Clinical features of brachial plexus injuries

Common brachial plexus injuries includes stretch, rupture, and avulsion

Certain patterns are more frequent like

Supraclavicular injuries (C5-6, C5-7, C8-T1, or pan-plexus)

Retroclavicular injuries (divisions)

Infraclavicular injuries (cords and terminal branches).

C5-6 Injury

These patients have

Motor deficits in shoulder stability, abduction, and external and internal rotation (supraspinatus and infraspinatus, deltoid, subscapularis),

as well as in elbow flexion (biceps, brachialis, and brachioradialis) and forearm supination (supinator).

Sensory deficit will be present in the C5 and C6 distributions. Elbow extension is normal, as is wrist and hand function. This pattern of injury is commonly referred to eponomously as Erb's or Erb-Duchenne palsy in recognition of the early work of Wilhelm Heinrich Erb and Guillaume Duchenne on peripheral nerve injury.

C5-7 Injury

In these patients, there will be variable weakness of the elbow, wrist, and sometimes finger extensors along with deficits of C5 - C6. The C7 contribution to wrist and finger extension and even to the flexor digitorum profundus muscles varies between patients and leads to different degrees of weakness. Sensory disturbances in the proximal part of the arm, as well in the thumb and index and middle fingers, may be present. This at times is referred to as an “Erb's-plus” pattern.

C8-T1 Injury

These patients will have weakness of the hand intrinsics, as well as variable weakness of the hand extrinsics and finger extensors, depending on the C7 contribution to these territories. Sensory loss over ulnar two

digits, medial aspect of the forearm, and distal part of the arm may be present.

Involvement of the lower roots can result in Horner's syndrome, which is noted on examination by

a) miosis (constricted pupil).

b) Ptosis of the upper eyelid,

c) Anhidrosis,

d) Enophthalmos

This pattern of injury is referred to as Klumpke's or Dejerine-Klumpke palsy.

Pan-plexus (C5-T1) Injury

Traumatic injury to the entire brachial plexus (C5 to T1) with supraclavicular brachial plexus injuries. These patients most commonly have a completely flail arm and insensate hand. Occasionally, certain elements may be partially injured.

Infraclavicular and Terminal Branch Injury

Retroclavicular or infraclavicular brachial plexus injuries may involve injuries at the division or cord level. Clavicular fracture is often

present in these cases. A few patterns are more commonly seen, including injuries to the posterior cord (radial and axillary nerve distributions), as well as isolated axillary or suprascapular nerve injuries.

Symptoms

Brachial plexus injury should be suspected in severe shoulder girdle injuries, especially in two-wheeler accidents. The mechanism of injury has to be analysed, as these may occur in polytrauma. In a polytrauma the evaluation of brachial plexus injury is done only after treating the polytrauma according to the ATLS protocols

A detailed examination of the upper extremity is needed and the clinical findings should be documented.

The patient may present with the following symptoms:

- Pain, in the neck and shoulder. This symptom is common with rupture.
- The affected limb is paralysed or dysesthetic.
- The affected limb feels heavy and weak
- The affected limb might show subtle signs of ischaemia if associated with vascular injury

Features of preganglionic root avulsion injury.

1. Motor paralysis extending to the proximal shoulder girdle and neck muscles such as the levator scapulae, rhomboids, serratus anterior and deeper posterior paravertebral muscles.

2. Sensory disturbances extending above gleno-humeral joint (i.e C4-3 sensory zone)

3. Intolerable pain (root "shooting" or differentiation pain)

4. Horner's syndrome;

5. No or weak Tinel'S sign in response to percussion of the neck;

6. Cervical spine fracture.

7. Elevation of hemi diaphragm.

8. Pseudomeningocele on standard cervical myelography or computed tomographic myelography.

9. Recording of sensory nerve action potential in the anesthetic limb and

10. Negative intraoperative somato-sensory evoked potentials.

Avulsion: The nerve roots are torn from the spinal cord.In high-energy traumatic brachial plexus injuries, such as occurs in a motorcycle or off-road vehicle accident multiple root avulsion are common

Features of postganglionic or more distal injury includes

1) Tenderness to percussion in the supraclavicular or infraclavicular region
2) Absence of sweating in the distribution of the injured nerve (sympathetic interruption)
3) Minimal preservation of movement (partial injury).
4) An advancing Tinel'S sign is suggestive of a recovering lesion.

Other clinical examinations

Associated injuries including musculo-skeletal injuries of same limb, chest wall, head injuries etc

Testing of the distal spinal accessory (XI cranial) nerve, which supplies the trapezius muscle

Active and passive range of motion of the joints

Vascular system of the affected upper extremity

INVESTIGATION

x-ray cervical spine,shoulder girdle, and humerus to rule out upper limb fractures and dislocations.

Chest radiographs - presence of rib fractures and elevated diaphragm. An elevated diaphragm indicates phrenic nerve injury, as the nerve originates from the proximal C3-5 nerves indicates a probable pre-ganglionic brachial plexus injury. The presence of cervical transverse process. First or second rib fractures may be associated with brachial plexus avulsion injuries. Rib fractures may be important if the intercostal nerves are to be considered for nerve transfers.

Myelography and computed tomographic (CT) myelography – presence of traumatic pseudomeningoceles performed at least 3 to 4 weeks after the injury. Magnetic resonance imaging (MRI) also can reveal traumatic pseudomeningoceles, large neuromas, rootlet abnormalities, inflammation, edema, and mass lesions. Magnetic resonance angiography - source of arterial supply for FFMT Pulmonary Function Tests Patients with a history of chest wall trauma and phrenic nerve dysfunction should have pulmonary function tests performed to better characterize their pulmonary function.

Electrodiagnostic Evaluation

Electrodiagnostic studies can confirm the diagnosis, localize and characterize partial versus complete injury, the nerve lesion, and subclinical evidence of recovery.

A baseline examination should be done 3 to 4 weeks after the traumatic injury to allow wallerian degeneration to occur and the electrodiagnostic study to reflect the nerve injury.

The electrodiagnostic evaluation also includes electromyography (EMG) and nerve conduction studies (NCSs). EMG evaluates and records the electrical activity of muscles at rest and with activity.

Changes reflective of a denervation injury include the presence of fibrillation potentials at rest and absent (complete injury) or reduced (partial injury) motor unit potentials with voluntary effort. Over time, nascent motor unit potentials (low in amplitude, polyphasic in configuration, and of variable duration) may appear and suggest reinnervation. NCSs, especially sensory nerve action potentials (SNAPs) is helpful in evaluation of the level of nerve injury. In preganglionic injuries, the dorsal root ganglion, where the sensory neuron cell body is located, is intact. The distal axons do not undergo wallerian degeneration because they remain connected to the cell body - the SNAP is preserved.

However, the patient is insensate because the sensory neurons are not connected to the central nervous system (i.e., spinal cord and brain). The finding of intact SNAPs in the presence of dermatomal anesthesia is pathognomonic of a root avulsion injury. In postganglionic injuries, the sensory axons will degenerate and the SNAP will be lost. On occasion, a segmental or longitudinal injury will cause both preganglionic and postganglionic lesions, and the SNAP will be absent in the presence of a root avulsion injury. On the contrary, motor conduction will be absent with both preganglionic and postganglionic injuries because the motor axons will have undergone wallerian degeneration (i.e., because their cell body is located in the anterior horn of the spinal cord).

NON-SURGICAL TREATMENT

Regeneration of nerve occurs in patients with a stretch neurapraxia, But recovery is unpredictable. Thorough clinical examinations and electro diagnostic studies over the first three to six months after the injury is needed. Surgery may become necessary in patients with no recovery clinically.

INDICATIONS FOR SURGERY

Surgery is indicated in patients with no hope for spontaneous recovery or for further recovery.

All patients with laceration injuries in proximity to the brachial plexus.

In patients with gunshot and traction injuries after a period of observation where there is no clinical or electrophysiologic evidence of recovery.

In patients with complete nerve root avulsion or nerve rupture. no definitive study or sign is sufficiently reliable;

Hence decision should be made after analyzing the different evaluations (clinical examination, imaging, & electrodiagnostic studies) in the context of time.

CONTRAINDICATIONS

Contraindications to undergo the surgery.

- Contractures of the joints
- Edema
- Old age patients with co morbid conditions.
- Lack of motivation in the patient or understanding the surgical goals

The patient selection, timing of surgery, and prioritization of restoration are the three crucial factors in restoration of upper arm function after brachial plexus injury.

Open injuries by sharp objects needs immediate exploration and direct, end-to-end repair can be done. In open injury from a blunt object, debridement and tagging of the nerves is done and after 3- to 4-week delay nerve repair is done.This procedure allows injured nerve ends to demarcate during re-exploration. Observation is needed in low-velocity gunshots injuries as it may be neuropraxic. Early exploration for significant soft-tissue damage should be done in high velocity gunshot injuries

The options for surgery includes primary nerve and secondary soft-tissue reconstruction. External neurolysis with nerve in continuity that exhibits a nerve action potential (NAP) alone can benefit to recovery. Postganglionic neuromas or ruptures may benefit from nerve grafts which may include C5 for shoulder abduction, C6 for elbow flexion, and C7 for elbow and wrist extension.

In preganglionic root avulsion injuries nerve transfers can be performed to accelerate recovery. Nerve transfers performed ideally within 6 months, reduce time to reinnervation by reducing the distance to the site of the nerve injury. The sources for transfer may be intraplexial or extra plexial. Some Intraplexial donors include ulnar nerve fascicles, median nerve fascicles, contralateral C7, medial pectoral nerve, nerve to long head of tricep, extraplexial donors includes the spinal accessory nerve, intercostal nerves, phrenic nerve.-

Significant recovery after nerve grafting can take more than 18 months, during this period of recovery joint mobility, minimizing edema, and treating de-afferentation pain has to be taken care

The age of the patient also becomes a significant factor in nerve recovery. Many surgical options are reserved for younger patients, in

patients with advanced age ability of nerve transfers to restore functional strength decreases dramatically.

In our study 21 patients were analysed after nerve transfers with brachial plexus root avulsion injuries. All patients were followed up at regular intervals after every procedure

Each patients were analysed after a detail history, physical examination, followed by electrodiagnostic studies, if necessary MRI of cervical spine and neck

The following proforma was filled for all brachial plexus injuries. Most of our patients visit our hospital with a referral, investigations including radiological and electrodiagnostic studies.

The same proforma was used for follow up of the patients.

PROFORMA FOR BRACHIAL PLEXUS INJURY EVALUATION

I.R.R.H.&DPS,

STANLEY MEDICAL COLLEGE

GOVT STANLEY HOSPITAL

CHENNAI

PS Number: Date:

Name: Age---------- Sex:-----

Address:

Phone number: Email ID:

Side involved: Dominant Hand:

Date of Accident: Duration since Injury:

Mode of Injury: RTA/Industrial / assault/ Others

Educational Qualification

Occupation-

Monthly income

Absence of duty in months

Money spend so for –Surgery and others

Number of person in the family

Any other persons employed

Socio-economical status

Nature of Injury : Low energy ---------- High energy----------

Mechanism of injury: Neck-shoulder---------arm-shoulder----------separation

History of pain: Continuous/occasional/no pain

Other injuries : Head Spine chest wall

abdomen Upperlimb Lower limb

Horner's Syndrome : Yes---------- No---------

Other associated injuries Yes---------- No---------

Tinel's sign at supraclavicular fossa: Yes----- No-----

Peripheral pulses:

MUSCLE POWER ASSESMENT

	ACTION OF MUSCLES	MUSCLE TESTED	PRELIM	REVIEW			
				I	II	III	IV
SCAPULA	Elevators	LEVATOR SCAPULAE (C3,4)					
		UPPER TRAPEZIUS (CN XI, C3,4)					
	Retractors	RHOMBOIDS (C5)					
	Protracto RS	SERRATUS ANTERIOR (C5,6,7)					
SHOULDER	Flexors	ANTR DELTOID (C 5,6)					
	Abductors	MIDDLE DELTOID (C5,6)					
		SUPRASPINATUS (C5,6)					
	Horizontal abductors	POSTR DELTOID (C5,6)					
	Adductors	PEC MAJOR -CLAVICULAR (C5,6,7)					
		PEC MAJOR -STERNAL (C6,7,8 T1)					
	Extensors	LAT DORSI (C6,7,8)					
		TERES MAJOR (C5,6)					
	Internal rotators	C5 – T1					
	External rotators	INFRASPINATUS (C5,6)					
		TERES MINOR (C5,6)					
ELBOW	Flexors	BICEPS (C5,6)					
		BRACHIORADIALIS (C5,6)					
	Extensors	TRICEPS (C7,8)					
FOREARM	Supinators	SUPINATOR (C6)					
		BICEPS (C5,6)					
	Pronators	PRONATOR TERES (C6,7)					
		PRONATOR QUADRATUS (C8T1)					
WRIST	Extensors	ECRL (C6,7)					
		ECRB (C6,7)					
		ECU (C6,7,8)					
	Flexors	FCR (C6,7)					
		FCU (C7,8T1)					
		P. L. (C7,8)					
HAND		FDS					
		FDP					
		INTRINSICS-----P.A.D					
		INTRINSICS----D.A.B					
		THUMB----OPPOSITION					

RANGE OF MOVEMENTS:

Shoulder	Active	Passive
FLEXION		
EXT		
ABD		
ADD		
IR		
ER		

	Active	Passive
Elbow- Flx		
Elbow- Ext		
F.Arm-Sup		
F-Arm-Pro		
Wrist – Flex		
Wrist- Ext		

RANGE OF MOVEMENTS:

FINGER	MCP joint		PIP joint	DIP joint
	Active	Passive	Active-Passive	Active-Passive
Index				
Middle				
Ring				
Little				
Thumb				

MOTOR INVOLVEMENT

MERLE d'AUBIGNE CHART

Shade boxes with colour pencils: Muscles power 4-5: GREEN Muscles power 3: YELLOW Muscles power 0-2: RED

<table>
<tr><td colspan="3">C6</td><td colspan="3">C8</td></tr>
<tr><td colspan="2">C5</td><td colspan="2">C7</td><td colspan="2">T1</td></tr>
<tr><td colspan="3">SERR. ANTERIOR</td><td colspan="2">FDS ALL FINGERS</td><td>APB/
OP/FPB</td></tr>
<tr><td rowspan="4">SHOULDER
ABDUCTORS</td><td rowspan="3">ELBOW
FLEXORS</td><td>PRO.
TERES</td><td colspan="2" rowspan="2"></td><td rowspan="2">ADD.
POLL</td></tr>
<tr><td colspan="2">P.LONGUS & FCR</td></tr>
<tr><td>ECRL</td><td>TRICEPS</td><td>FPL</td><td rowspan="2">HYPO
THENARS</td></tr>
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RADIALIS</td><td>ECRB</td><td>EPL</td><td rowspan="2">FDP
I/II</td></tr>
<tr><td>SHOULDER
EXT.
ROTATORS</td><td rowspan="2">SUPINATOR</td><td rowspan="2">EIP
EDM</td><td>EDC</td><td>ECU</td></tr>
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III/IV</td><td>INTERO
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<tr><td colspan="2">L.D</td></tr>
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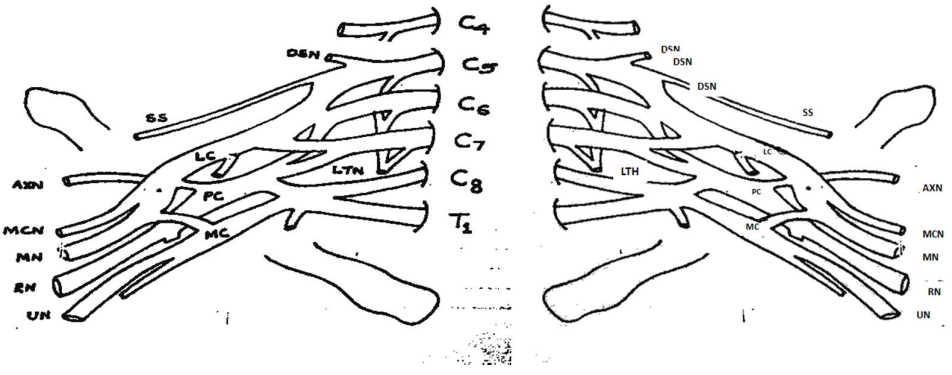
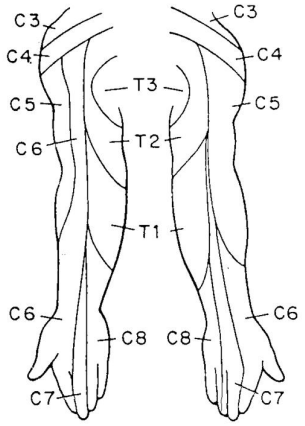
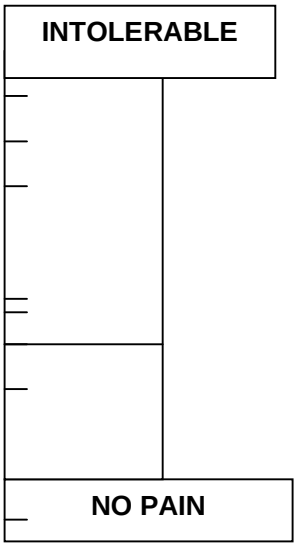


SENSORY INVOLVEMENT





VISUAL ANALOG SCORE FOR PAIN

SENSATION ASSESSMENT

(Please fill in red color for total anaesthesia

Yellow for diminished protective sensation

Green colour for normal)

Investigation reports and findings

X-ray Cervical spine:

X-ray chest –in inspiration and in expiration:

X-ray shoulder:

CT myelography:

MRI Scan:

EMG Studies:

DIAGNOSIS

Probable level of lesion:

Probable site of lesion:

Probable nature of lesion:

PLAN

Physical:-

Surgical:-

Protocols of management

1. Conservative management for 0-3 months in case of blunt injuries.
2. Penetrating injuries, lacerated wounds, associated vascular injuries primary nerve repair during the same exploration
3. Basic investigations for systemic problems, electro diagnostic studies and MRI cervical spine if necessary after 3 weeks of injury
4. Supportive shoulder-arm sling was advised at the time of 1st visit to the hospital
5. Physiotherapy for shoulder, arm, forearm and hand along with electrical stimulation after 3 weeks of injury
6. Follow up of patients at each month to note the signs of recovery
7. Exploration of brachial plexus at 3rd month when there are no signs of recovery.
8. In post ganglionic nerve rupture primary neuroraphy was performed with end to end anastamosis or bridging nerve grafts were used
9. Primary nerve transfers during exploration in root avulsion injuries for shoulder

10. Nerve transfer to elbow planned depending on per op findings

    a)if C8 & T1 are intact nerve transfer to elbow is done after 3 months to wait for the recovery of hand in pan BPI

    b)if hand functions are normal nerve transfer (Oberlin) is performed during the same exploration

    c)if hand functions does not recover intercostals nerve transfer was used.

11. Other procedures includes contralateral C7 transfer using vascularised ulnar nerve graft to median nerve to restore hand function. Muscle transfer for shoulder elbow and hand functions if nerve repair or nerve transfer fails or delayed presentation of the patient after 18 months

In our study all patients have undergone the above protocols and 21 patients were studied in root avulsion injuries the nerve transfers done in our institute were

1. spinal accessory to supra scapular nerve transfer for shoulder
2. intercostal nerve to musculo cutaneous nerve for elbow flexion
3. oberlin 1 for elbow flexion in patients with good hand functions

Pre – op preparation

Informed written consent

Parts preparation includes neck, supraclavicular region, both legs for sural nerve grafts

Anaesthetic assesment

Operative procedure

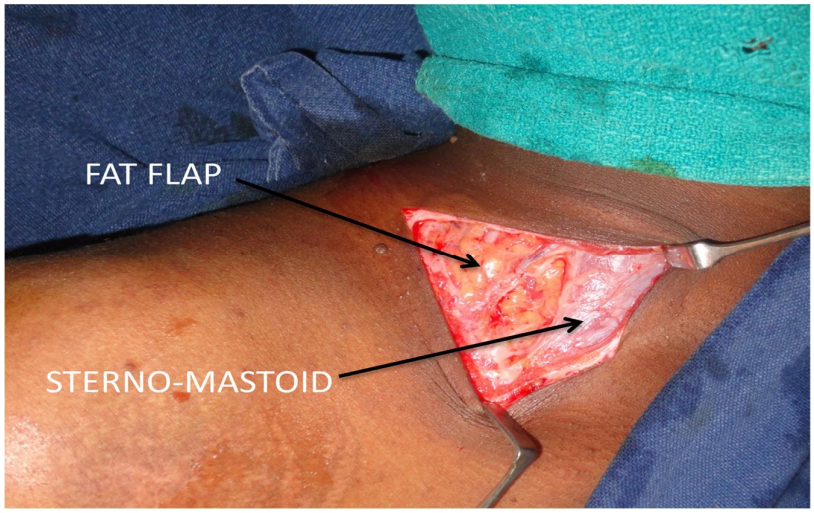
Positioning of the patient

Supine position, venous catherisation, indwelling urinary catheter, small sand bag or pillow is kept beneath the ipsilateral scapula. Neck kept in extension and turned to the opposite side. Draping and preparation of neck, mandible, hemithorax, axilla, entire upper limb and lower limb for sural nerve graft. Bipolar-coagulator, electrodes, magnifying loupes or microscope for exploration is used all patients are operated under general anaesthesia. Long-acting paralytic agents, muscle relaxants were avoided.

Surgical approach

Supraclavicular a single transverse 5 to 6cm incision, parallel to the clavicle. With this approach C5 through T1 nerves can be exposed along with spinal accessory nerve, suprascapular nerves and trunks. The infraclavicular plexus if necessary is exposed with an incision over the deltopectoral groove or these two incisions can be connected.

After the skin incision is made, the platysma is incised and the cutaneous cervical plexus are identified and protected. Skin flaps along with platysma are raised both superiorly and inferiorly. The external jugular vein over the sternocleidomastoid muscle is identified and retracted. The superficial layer of deep cervical fascia and cervical pad of fat are retracted raised as a fat flap from superior border of clavicle based lateraly.



EXPLORATION -SUPRACLAVICULAR APPROACH

The omohyoid muscle and transverse cervical vessels are seen, if necessary divided or retracted. The upper trunk is visualized immediately. Medially, the phrenic nerve is found on the anterior surface of the scelenus anterior muscle Contraction of the diaphragm after electrical nerve stimulation will confirm identification. The anterior scalene muscle is retracted and traced proximally, the C5 phrenic contribution will be made

out for identification of the C5 nerve root.The upper trunk is exposed proximally with origin. The C5 nerve is usually smaller, superior, lateral, and more vertical than the C6 nerve. The upper trunk is traced distally to its anterior and posterior division and the origin of the suprascapular nerve. The C7 nerve and middle trunk are visualized between anterior and middle scalene muscles. Even more inferior and posterior are the C8 and T1 nerves forming the lower trunk, which are closely associated with the subclavian artery.

The infraclavicular approach to the brachial plexus will expose the cords and branches. After the skin incision, the deltopectoral groove is developed to identify the cephalic vein, thoracoacromial artery and its accompanying veins. The tendinous origin of the pectoralis minor is divided from the coracoid process to expose the infra clavicular plexus. After incising the clavipectoral fascia the lateral cord, which is superficial and lateral to the axillary artery is exposed. The posterior cord lies lateral and deep to the axillary artery, and the medial cord lies medial and deep to the axillary artery. Medial and lateral pectoral nerves should be preserved which arises at this level. The lateral cord is identified by tracing the median nerve proximally. Musculocutaneous nerve is identified which branches laterally piercing the coracobrachialis muscle. The medial cord is identified by tracing the median nerve proximally then followed distally to

the ulnar, medial brachial cutaneous, and medial antebrachial cutaneous nerves. Medial and deep to the axillary artery and vein and coursing laterally is the radial nerve. It is followed proximally to the posterior cord; the axillary nerve can then be seen branching from the posterior cord. Once the supraclavicular and infraclavicular brachial plexus are exposed, a tunnel is made under the clavicle, the most lateral part of the clavicular attachment of the pectoralis major muscle is detached; the subclavius muscle is divided. suprascapular vessels, are ligated. The clavicle is retracted with a heavy tape, to expose the divisions of the brachial plexus. If needed clavicular osteotomy is done after predrilling of the screws for plate fixation. Major vascular and pleural damage must be considered in infraclavicular plexus exploration.

SCAR AFTER A SUPRA CLAVICULAR INCISION

After thorough exploration the findings are noted. In C5-C6 root avulsion injuries the priorities are shoulder stability, abduction and external rotation, in elbow flexion. Hence nerve transfer to reinnervate supraspinatus and infra spinatus, deltoid is necessary. Elbow flexion can be achieved by neurotisation of biceps or brachialis.

In C5-C7 root avulsion injuries the same procedure is followed elbow extension is assisted by gravity. Nerve transfer to neurotise deltoid is not possible.

In pan brachial plexus palsy with complete root avulsions priorities are

a) Shoulder stabilization, abduction, and external rotation by reinnervation of the suprascapular nerve

b) Elbow flexion by reinnervation of the biceps/brachialis muscle the triceps muscle should also be considered for reinnervation

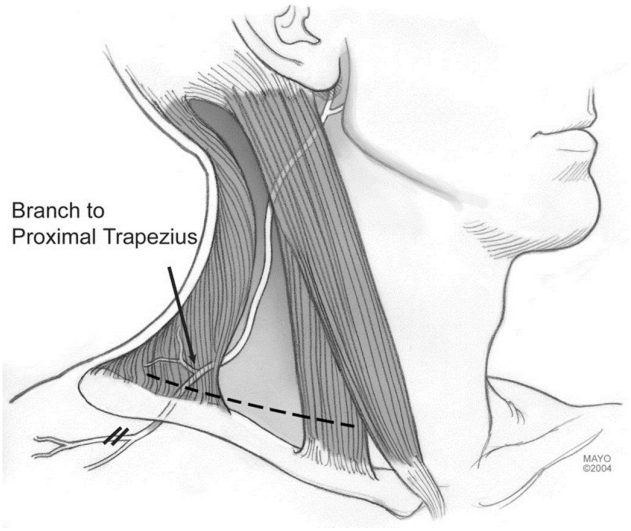
c) Wrist and finger flexion. Hand sensation by reinnervation of the lateral cord (C6-7 distribution). Intrinsic hand muscle function. The donor nerves are very limited and mostly extra plexial or from the other normal side. Spinal accessory, intercostals, phrenic, contralateral C7 root are the available donor nerves

In our institute we have utilized spinal accessory, intercostals, ulnar fascicles, contralateral c7 as donor nerves to neurotise the affected limb based on the intro-op findings and recovery.

Spinalaccessory to suprascapular nerve transfer

Surgical Anatomy of the spinal accessory nerve

The spinal accessory nerve originates in the posterior cranial fossa from both spinal and cranial nerve roots, traversus through the jugular foramen and branches into “cranial part” an internal branch that joins the vagus (X) nerve and “spinal part” an external branch which supplies the sternocleidomastoid and trapezius muscles. The spinal accessory nerve after supplying the sternocleidomastoid descends obliquely in the posterior triangle of the neck, it passes through loose connective tissue in between the superficial and deep layers of the deep cervical fascia. This is the commonest site of iatrogenic injuries of spinal accessory nerve. The spinal accessory nerve supplies to the upper part of the trapezius muscle with two or three branches then it courses on its anterior edge. Intramuscularly, the nerve passes obliquely in a caudal course toward the middle and lower parts of the muscle and gives off branches to the muscle during its course.



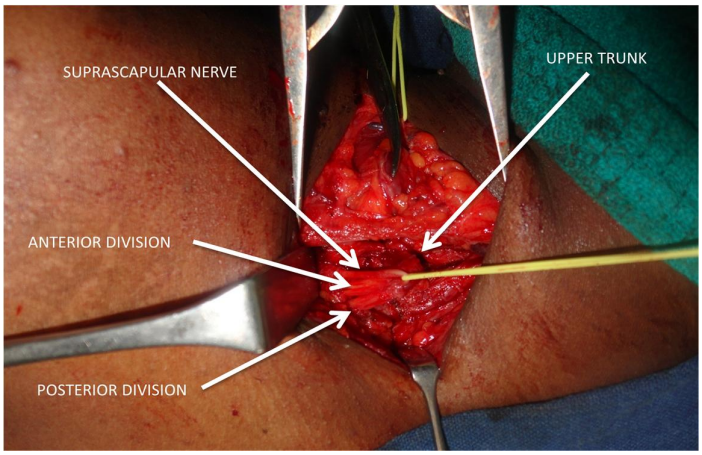
Spinal Accessory Nerve Dissection

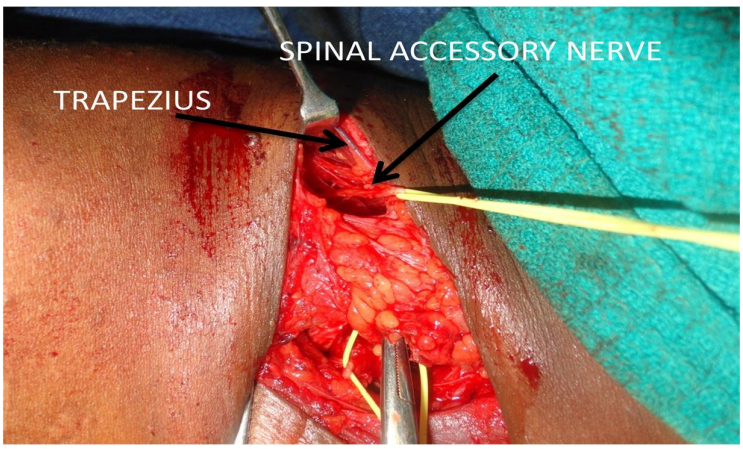
The spinal accessory nerve is exposed from the posterior border of the sternocleidomastoid muscle upto the undersurface of the trapezius, where it is transected as distally as possible and then transferred to the suprascapular nerve. The response of the trapezius to electrical stimulation is confirmed before transaction of the spinal accessory nerve. Usually the proximal branch to the upper portion of the trapezius is preserved.

No serious complications has been encountered in this procedure

The suprascapular nerve, originates from the upper trunk 2 to 3 cm above the clavicle which innervates the supraspinatus and infraspinatus muscles. The course of the nerve is lateral and posterior, traverses deep to the omohyoid muscle to enter the supraspinatus fossa through the suprascapular notch, and also deep to the superior transverse scapular

ligament. The nerve passes deep to the supraspinatus muscle and winds around the lateral border of the spine of the scapula - the spinoglenoid notch to enter the infraspinatus fossa.





The nerve transfer is performed by coaptation of spinalaccesory nerve which is divided in the supraclavicular fossa to the suprascapular nerve at origin from the upper trunk without an intervening nerve graft.

Intercostals nerve to musculocutaneous nerve neurotisation

Operative Procedure

Motor innervations of musculocutaneous nerve is achieved by transfer of multiple intercostals nerve usually the third to sixth intercostal nerves are used as they have the most length to reach the musculocutaneous nerve. When the dissection is extended anteriorly to the costochondral junction, sufficient intercostal nerve length is gained, hence direct coaptation to the target motor branch is possible eliminating the need for interpositional nerve grafts. Intercostal nerves run within the intercostal space along the pleural side of the internal intercostal muscles Posteriorly, they pass between the two layers of intercostal muscles that insert on the posterior thirds of the ribs. Posterior to the axilla, they enter deep to the intercostal muscles and run anteriorly between the transverse thoracic muscles and the endothoracic aponeurosis. The lateral cutaneous branch pierces the intercostal muscle toward the skin and divides into a dorsal and a ventral branch. The anterior cutaneous branch pierces the pectoralis major close to the sternum and ramifies into the skin.

The third to sixth intercostal nerves are explored through an inframammary incision extending from the mid-axillary line to the costochondral junction. This incision typically connects with the proximal arm incision used for exposure of the musculocutaneous nerve. The subcutaneous tissue and underlying pectoralis major and minor muscles are elevated from their distal insertions so that the muscles themselves are not injured.

The intercostobrachial nerve, the second intercostal nerve, is preserved. The anterior surfaces of the selected ribs, as well as their intercostal musculature, are exposed the long thoracic nerve and thoracodorsal vessels are found in posterior to the mid-axillary line. The anterior surface of each rib is incised and the periosteum is circumferentially protecting the pleura, an umbilical tape elevating the rib, identify and dissect the intercostal nerve.

The periosteal sleeve is incised to identify the intercostal nerve. The motor intercostal nerve can also be identified by tracing the lateral sensory branch proximally, or by finding the flash of bleeding from the intercostal artery and vein, which are in close proximity to the nerve. Electrical stimulation can be used to confirm the motor branch. If the periosteum was breached during subperiosteal rib dissection, the underlying intercostal nerve is sometimes exposed and can be seen immediately. When

identified, the nerve is mobilized in a vessel loop and dissected. The motor branch of the intercostal nerve can be isolated and traced anteriorly toward the costochondral junction by gentle spreading of the intercostal muscles. Dissection of the motor branch is continued as far anteriorly and posteriorly as necessary to gain the required length to reach the target nerves.

The technique is repeated for harvesting the other intercostal nerves required for reconstruction. After appropriate dissection, each intercostal nerve is transected distally and passed through the serratus anterior muscle into the axillary region. Pleural tear and air leak should be noted and treated either by pleural repair, tight skin closure, or placement of a chest tube, depending on the extent of the tear or leak.

Usually three to four Intercostal nerves are used for neurotisation of musculocutaneous nerve for restoration of elbow flexion. This transfer will maximize the number of motor fibers and minimize the number of sensory fibers that will be targeted by the transfer the intercostal nerve transfer into the musculocutaneous nerve itself. The nerve repair is done with the arm abducted and externally rotated to ensure that these motions will not lead to undue tension on the coaptation site.

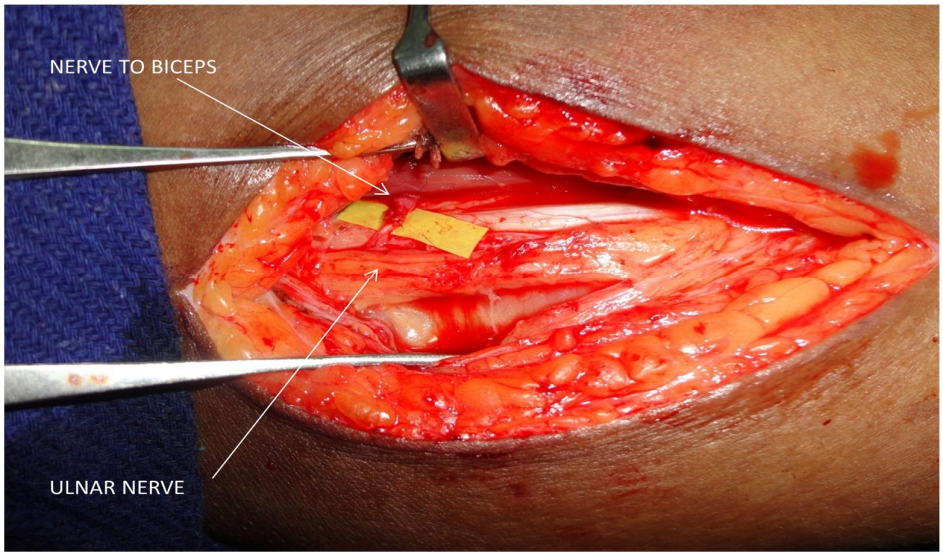
OBERLIN 1 TRANSFER

In patients with preserved C8-T1 function, transfer of a functioning ulnar nerve motor fascicle for reinnervation of the biceps muscle Using upper arm incision musculocutaneous nerve may be explored. The nerve takes its origin from the lateral cord of the brachial plexus distal to the coracoid process.

Piercing the coracobrachialis muscle, the nerve passes on the deep surface of the biceps. It gives rise to the motor branch to the biceps, the branch to biceps enters approximately 12 cm distal to the acromion and a motor branch to the brachialis muscle at about 17 cm distal to the acromion and continues as the lateral antebrachial cutaneous nerve.

Both the musculocutaneous and ulnar nerves are exposed through the same skin incision in the proximal upper part of the arm. After the type of motor branch to the biceps is confirmed, the branch is divided sufficiently proximal to be long enough to reach the ulnar nerve. The ulnar nerve is identified and intraepineurial dissection is performed under loupe or microscope magnification. The ulnar fascicles are tested with a nerve stimulator and the fascicles mostly innervating the flexor carpi ulnaris muscle, generally located posteromedially, are identified.

Depending on the size of the motor branch to the biceps, one or two fascicles are selected. These chosen fascicles are transected just proximal to distal interfascicular connections under magnification. They are then coapted without tension to the motor branch to the biceps with 9-0 or 10-0 nylon epineural suture.



The skin incisions are closed with 3-0 nylon intermittent vertical mattres sutures.

Drains were kept and were removed at 2nd post op day or once the drain becomes minimal.

All patients were kept in post op icu for 24 – 48 hrs and then transferred to post op wards.

SCAR AFTER OBERLIN TRANSFER

OBSERVATION AND RESULTS

A demographic analysis was done for 134 cases of brachial plexus presenting at our Institute 2007-2011 and 21 cases were analysed which fulfilled the inclusion and exclusion criteria.

I AGE

S.NO	AGE DISTRIBUTION	TOTAL CASES
1	14-20 years	04
2	21-30 years	11
3	31-40 years	05
4	41-50 years	01

II SEX – 20 MALE 1 – FEMALE

III LEVEL OF INJURY

PANPALSY	C5,6	C5,6,7
6	6	9

IV SIDE OF INJURY

SIDE	RIGHT	LEFT
	11	10

V MODE OF INJURY

MODE OF INJURY	
R.T.A	17
FALL FROM HEIGHT	02
FALL OF WEIGHT OVER SHOULDER	01
INDUSTRIAL	01

VI OCCUPATION

OCCUPATION	
STUDENT	**4**
MANUAL LABOURER	**16**
SEDENTARY WORKER	**1**

VIII SURGERIES DONE FOR UPPER BPI

NERVE TRANSFERS	**PATIENTS**
SA TO SSN	20
OBERLIN 1	9
ICN TO MCN	1

IX RESULTS OF SURGICAL CORRECTION

SURGERY DONE	IMPROVED	NOT IMPROVED
TRANSFER OF SPINAL ACCESSORY NERVE TO SUPRASCAPULAR NERVE	15	5
OBERLIN NERVE TRANSFER	8	1
ICN TO MCN	0	1

POST –OP RESULT IN A PATIENT AFTER

SA TO SSN AND OBERLIN TRANSFER

Patient with C5,C6 ,C7,C8,T1 lesion – exploration neurolysis, avulsed C5,C6 roots with intact C7,C8,T1,showing shoulder abduction and flexion of elbow

Discussion

All the patients were subjected for clinical evaluation, investigations and explained in detail about the procedure, post-op management physiotherapy. All the patients and the family members were counselled by the social work team regarding the ailment and their participation in the treatment

All the patients were explored only by a supra clavicular transverse incision.In case of post ganglionic rupture end to end neuroraphy or bridging sural nerve grafts were done. In pre-ganglionic root avulsion decision was made according to the per- op findings. In C5, C6 and C5, C6, C7 root avulsions with intact C8,T1,neurolysis & spinal accessory to supra scapular nerve transfer is done. Oberlin transfer is done after the recovery of hand function. Extra plexial transfer or contra-lateral C7 transfer is planned later if there is no hand recovery. Oberlin 1 transfer is done during the same exploration in patients with good hand functions and intact C8, T1.

During exploration and nerve transfer, the nerve to be transferred is confirmed by electrical stimulation. The nerve repair is done 9-0 nylon under microscopic magnification and without tension. In our study nerve

grafts were not used for bridging. Nerve fascicles for ulnar nerve transfer to biceps branch were selected to match the fascicles of nerve to biceps.

Post op follow up were done at every month, evaluation of recovery were documented in the charts at 3 months interval

Some patients lost follow up at regular intervals they were evaluated at op during their visit patients were advised post op physiotherapy and electrical stimulation at nearby government hospitals for outstation patients.

Post op follow up were made upto 2 yrs after the last procedure. The mean follow up period is 8-12 months

The tabulated results denote the patients final follow up. All the patients were called for the study. 16 of 21 patients turned up for the study, rest of the patients results are tabulated with records of their final visit.

Post – operative follow up of patients for donor morbidity did not reveal any major complications. Power of the muscle innervated by donor nerve were not affected. In a few cases there were improvement in hand functions after Oberlin transfer possibly due to the effect of neurolysis during exploration.

CONCLUSION

1. Road traffic accidents are the major cause of 90% brachial plexus injuries. Two wheeler accidents forms 98 % of RTA
2. Damage occurred to brachial plexus roots and trunks is directly proportional to the mechanism of injury
3. Duration of presentation to the hospital after the injury influences in planning the management
4. Early intervention in the form of exploration, neurolysis, nerve transfers helps in early recovery
5. Nerve recovery also depends on the number of fascicles transferred
6. In our study nerve transfers to shoulder and elbow done within 3 – 6 months had reasonably good recovery.
7. Muscle power regained for abduction and external rotation of shoulder were more than M3 in 40 % of patients
8. Muscle power regained in elbow flexion were more than M3 in 30 % of patients
9. 30 % of patients were satisfied with their regained power in shoulder.
10. 40 % of patients were satisfied with their regained power in elbow

11. However more than 50 % of patients did not turn up for nerve transfer for elbow after their procedure for shoulder.

    a) 70 % of the defaulters are due to financial reasons

    b) 20 % due to social reasons

    c) 10 % due to their dissatisfaction in the results of first surgery against their expectations

12. All the patients who had no recovery of shoulder or elbow were explained about secondary procedures only 30 % underwent secondary procedures
13. During the study evaluation defaulters were motivated for secondary procedures and about 70 % are willing to undergo the procedures
14. About 30% of patients returned to their original job after recovery.
15. About 20% of patients changed their jobs to sedentary jobs
16. More than 40 % of patients are house bound.
17. About 80 % of patients who had improvement after surgeries were able to do 60 to 70% of activities of daily life
18. Patients did not have any major site donor morbidity

19. About 80 % of patients expected or suggested the need for monitory benefits or travel concession from the government at least for their follow up visits to the hospital since they are financially handicapped after the injury

20. A team approach has to be planned for all brachial plexus injury patients which should include brachial plexus surgeon, physiatrist, physiotherapist, medical social workers to overcome the problems of the patients

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PROFORMA FOR THE STUDY

1. NAME-

2. AGE/SEX-

3. PS NO-

4. ADDRESS-

5. MOBILE NO-

6. OCCUPATION-

7. SOCIOECONOMIC STATUS-

8. HAND DOMINANCE-

9. DATE OF INJURY-

10. NATURE OF INJURY-

11. DATE OF SURGERY-

12. OTHER INJURIES-

13. OTHER CO-MORBIDITIES

14. TYPE OF SURGERY

15. DURATION BETWEEN INJURY AND SURGERY

16. ASSESMENT OF FUNCTIONS

SHOULDER

	PRE OP	POST OP
ABDUCTION		
ADDUCTION		
INTERNAL ROTATION		
EXTERNAL ROTATION		

ELBOW

	PRE OP	POST OP
FLEXION		
EXTENSION		

S.NO	PATIENT NAME	PRE-OP AND POST OP EVALUATION OF POWER AND MOVEMENTS																		REMARKS
		SHOULDER												ELBOW						
		ABD	ABD	ADD	ADD	ROM	ROM	IR	IR	ER	ER	ROM	ROM	FLEX	FLEX	EXT	EXT	ROM	ROM	
1	RAJA	M0	M3	M0	M0	NIL	0-40	M0	M0	M0	M1	NIL	0-20	0	M3	0	M0	NIL	0-90	IMPROVED
2	SHABEENA	M0	M3	M2	M2	0-30	0-40	M0	M0	M0	M2	NIL	0-20	0	M4	M4	M4	0-90	0-120	IMPROVED
3	NAVEEN KUMAR	M0	M0	M0	M0	NIL	NIL	M0	M0	M0	M0	NIL	NIL	0	M0	0	M0	NIL	NIL	NOT IMPROVED
4	UTHRAPATHY	M0	M3	M0	M0	NIL	0-40	M0	M0	M0	M1	NIL	0-20	0	M0	0	M0	NIL	NIL	IMPROVED
5	JAFFER	M0	M0	M0	M0	NIL	NIL	M0	M0	M0	M0	NIL	NIL	0	M0	0	M0	NIL	NIL	NOT IMPROVED
6	KUMAR	M0	M0	M0	M0	NIL	NIL	M0	M0	M0	M0	NIL	NIL	0	M0	0	M0	NIL	NIL	NOT IMPROVED
7	MANIKANDAN	M0	M2	M0	M0	NIL	0-30	M0	M0	M0	M1	NIL	0-20	0	M0	0	M0	NIL	NIL	IMPROVED
8	GOPAL	M0	M3	M0	M0	NIL	0-90	M0	M0	M0	M2	NIL	0-20	0	M3	0	M0	NIL	0-70	IMPROVED
9	ABIMANNAN	M0	M3	M0	M2	NIL	0-40	M0	M1	M0	M2	NIL	0-20	0	M3	0	M3	NIL	0-70	IMPROVED
10	SRINIVASAN	M0	M3	M2	M2	0-20	0-40	M0	M0	M0	M1	NIL	0-20	0	M3	M4	M3	0-90	0-70	IMPROVED
11	MANIKANDAN	M0	M4	M0	M0	NIL	0-90	M0	M0	M0	M3	NIL	0-30	0	M0	0	M0	NIL	NIL	IMPROVED
12	MURUGAN	M0	M0	M0	M0	NIL	NIL	M0	M0	M0	M0	NIL	NIL	0	M0	0	M0	NIL	NIL	NOT IMPROVED
13	BOOPATHY	M0	M2	M0	M0	NIL	0-40	M0	M0	M0	M1	NIL	0-20	0	M0	0	M0	NIL	NIL	IMPROVED
14	MURALI	M0	M3	M0	M2	NIL	0-40	M0	M2	M0	M2	NIL	0-20	0	M3	0	M3	NIL	0-90	IMPROVED
15	SAKTHIVEL	M0	M2	M0	M0	NIL	0-30	M0	M0	M0	M1	NIL	0-20	0	M0	0	M0	NIL	NIL	IMPROVED
16	BABU	M0	M0	M0	M0	NIL	NIL	M0	M0	M0	M0	NIL	NIL	0	M0	0	M0	NIL	NIL	NOT IMPROVED
17	RAMESH	M0	M4	M0	M0	0-20	0-90	M0	M0	M0	M3	NIL	0-30	0	M0	M4	M0	0-90	NIL	IMPROVED
18	MUNIAN	M0	M2	M0	M0	NIL	0-30	M0	M0	M0	M1	NIL	0-10	0	M0	0	M0	NIL	NIL	IMPROVED
19	KUMAR	M0	M3	M3	M0	0-30	0-40	M0	M0	M0	M1	NIL	0-20	0	M2	M4	M4	0-90	0-90	IMPROVED
20	SIVAKUMAR	M0	M3	M0	M0	NIL	0-40	M0	M0	M0	M1	NIL	0-20	0	M3	0	M3	NIL	0-90	IMPROVED
21	MUNIAPPAN	M0	M0	M0	M0	NIL	NIL	M0	M0	M0	M0	NIL	NIL	0	M0	0	M0	NIL	NIL	NOT IMPROVED

S.NO	PATIENT NAME	AGE	GENDER	SIDE	PRESENTATION AFTER INJURY	LEVEL OF LESION CLINICAL	PER –OP FINDINGS		NERVE TRANSFERS
							AVULSION	INTACT	
1	RAJA	45	MALE	LEFT	3 MONTHS	C5,C6,C7	C5,C6,C7	C8,T1	SA-SSN/OB- 1
2	SHABEENA	23	FEMALE	RIGHT	6 MONTHS	C5,C6	C5,C6	C7,C8,T1	SA-SSN/OB-1
3	NAVEEN KUMAR	22	MALE	RIGHT	8 MONTHS	C5,C6,C7	C5,C6	C7,C8,T1	SA-SSN
4	UTHRAPATHY	19	MALE	LEFT	5 MONTHS	C5,C6,C7,C8,T1	C5,C6,C7	C8,T1	SA-SSN
5	JAFFER	20	MALE	RIGHT	11 MONTHS	C5,C6,C7,C8,T1	C5,C6,C7, C8,T1		SA-SSN
6	KUMAR	35	MALE	RIGHT	8 MONTHS	C5,C6,C7,C8,T1	SCARRED & AVULSED		ICN-MCN
7	MANIKANDAN	20	MALE	RIGHT	10 MONTHS	C5,C6,C7	C5,C6,C7	C8,T1	SA-SSN/OB- 1
8	GOPAL	35	MALE	LEFT	6 MONTHS	C5,C6,C7	C5,C6,C7	C8,T1	SA-SSN/OB- 1
9	ABIMANNAN	27	MALE	LEFT	7 MONTHS	C5,C6,C7	C5,C6	C7,C8,T1	SA-SSN/OB- 1
10	SRINIVASAN	30	MALE	RIGHT	6 MONTHS	C5,C6	C5,C6,C7	C8,T1	SA-SSN/OB- 1
11	MANIKANDAN	27	MALE	LEFT	3 MONTHS	C5,C6,C7,	C5,C6	C7,C8,T1	SA-SSN
12	MURUGAN	23	MALE	LEFT	9 MONTHS	C5,C6,C7,C8,T1	C5,C6	C7,C8,T1	SA-SSN
13	BOOPATHY	24	MALE	LEFT	6 MONTHS	C5,C6,C7	C5,C6	C7,C8,T1	SA-SSN
14	MURALI	23	MALE	RIGHT	6 MONTHS	C5,C6,C7	C5,C6	C7,C8,T1	SA-SSN/OB- 1
15	SAKTHIVEL	20	MALE	LEFT	3 MONTHS	C5,6,7,C8,T1	C5,C6,C7	C8,T1	SA-SSN
16	BABU	31	MALE	RIGHT	10 MONTHS	C5,C6,C7,C8,T1	C5,C6,C7,C8,T1		SA-SSN
17	RAMESH	28	MALE	LEFT	3 MONTHS	C5,C6	C5,C6	C7,C8,T1	SA-SSN
18	MUNIAN	29	MALE	LEFT	5 MONTHS	C5,C6,C7,C8,T1	C5,C6,C7	C8,T1	SA-SSN
19	KUMAR	34	MALE	RIGHT	9 MONTHS	C5,C6	C5,C6	C7,C8,T1	SA-SSN/OB- 1
20	SIVAKUMAR	32	MALE	RIGHT	5 MONTHS	C5,C6,C7	C5,C6,C7	C8,T1	SA-SSN/OB- 1
21	MUNIAPPAN	25	MALE	RIGHT	10 MONTHS	C5,C6,C7	C5,C6	C7,C8,T1	SA-SSN